BRUSH ELECTRONICS COMPANY

INSTRUMENT DEPARTMENT

Look To BRUSH for Your Industrial And Research Instruments And Equipment

■ **Instruments for:**

- Electrical Measurements
- Physical Measurements
- Textile Measurements
- Resistance-Welding Measurements
- Surface Roughness Measurements
- Electro-Acoustical Measurements
- Seismic Measurements

■ **Equipment for:**

- Magnetic Recording
- Metal Classification

OPERATING INSTRUCTIONS FOR

DUAL CHANNEL D.C. AMPLIFIER

Model BL-530

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WARRANTY

We warrant each instrument manufactured by Brush Electronics Company to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and replacing any defective parts thereof (except pens, tubes, fuses and batteries).

This warranty is effective for one year after delivery to the original purchaser, when the instrument is returned transportation charges prepaid by the original purchaser, and which upon our examination proves to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at our current rate. In this case, an estimate will be submitted before the work is started.

Warranty card enclosed with shipment must be returned to establish warranty.

■ Claim for damage in Shipment

The instrument should be examined as soon as it is received. If it is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained from the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number, type number and serial number when referring to this instrument for any reason.

■ If any fault develops, the following steps should be taken:

1. Notify our Customer Service Department, 3405 Perkins Avenue, Cleveland 14, Ohio, giving full details of the difficulty, and include the model number, type number and serial number. Upon receipt of this information, we will give you service instructions or issue a material return authorization card.

2. You may request any necessary instrument packaging by telling us what cartons you need. These will be sent to you no charge.

3. Upon receipt of shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

SHIPPING

All shipment of instruments should be made via Railway Express.

PLEASE DO NOT HESITATE TO CALL ON US

BRUSH ELECTRONICS COMPANY

DIVISION OF CLEVITE CORPORATION

3405 PERKINS AVENUE • CLEVELAND 14, OHIO

DUAL CHANNEL D.C. AMPLIFIER Model BL-530

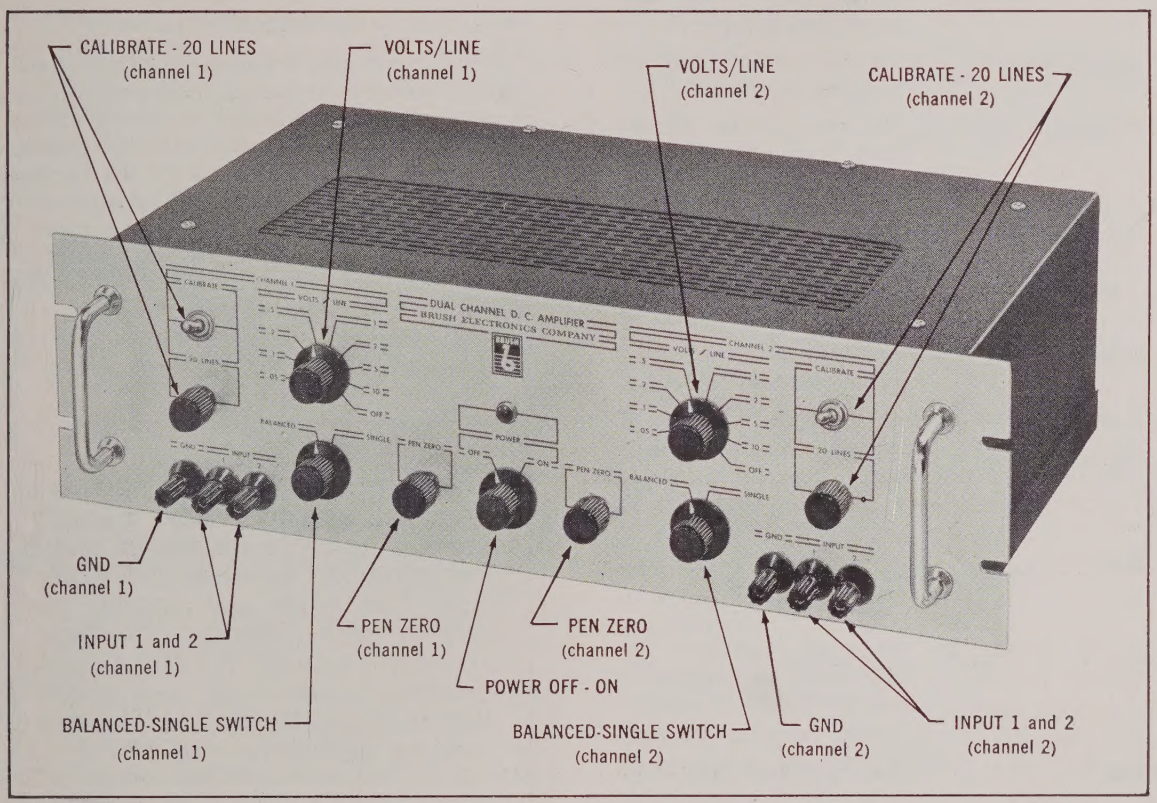
CALIBRATE - 20 LINES (channel 1)
VOLTS/LINE (channel 1)
VOLTS/LINE (channel 2)
CALIBRATE - 20 LINES (channel 2)
DUAL CHANNEL D. C. AMPLIFIER
BRUSH ELECTRONICS COMPANY
GND (channel 1)
INPUT 1 and 2 (channel 1)
PEN ZERO (channel 1)
POWER OFF - ON
PEN ZERO (channel 2)
BALANCED-SINGLE SWITCH (channel 1)
BALANCED-SINGLE SWITCH (channel 2)
GND (channel 2)
INPUT 1 and 2 (channel 2)

Fig. 1. Dual Channel D.C. Amplifier Model BL-530.

The Brush Dual Channel D.C. Amplifier Model BL-530 is designed to amplify two separate signals independently of each other in the voltage range between 50 millivolts and 400 volts. It has a linear response from 0 (d.c.) to 5000 cycles per second when used with any oscilloscope or similar apparatus. The Amplifier consists of two channels of balanced, direct coupled amplification with a maximum voltage gain of 25 each; an electronically-regulated power supply and a standard cell for calibration. An input switch permits the acceptance of either balanced or single ended input signals. The signal zero line may be offset up to an equivalent of 200 lines of chart paper, either side of chart center when single ended input circuits are used. This makes it possible to balance out an unwanted d.c. component and to amplify the dynamic component of a complex signal.

This Dual Channel D.C. Amplifier will fit a standard 19" rack or may be mounted in a specially designed Brush Portable Case Model BL-380, for semi-permanent, table-top applications.

SPECIFICATIONS

Maximum sensitivity	50 millivolts per chart line. Full scale deflection ±1 volt.
Measurement range	Single ended input — .050 volt to 400 volts. Balanced input — .050 volt to 20 volts. Maximum ± 10 volts each terminal to ground.
Zero line stability	¼ line of chart paper per hour. (Not affected by power line fluctuations between 105 and 125 volts or between 95 and 115 volts.) Total drift over eight hour period not more than ½ line of chart paper.
Input impedance	1 megohm (single ended), and 900 K ohms (balanced).

Signal expander	A pen positioning control is provided. Permits balancing out the d.c. or static component of a complex signal up to the equivalent of 200 lines either side of chart center, except when balanced input is used.
Attenuator steps	.05, .1, .2, .5, 1, 2, 5, and 10 volts per chart line.
Frequency response	Flat from d.c. to 100 cps when matched with Brush oscillographs. An adjustment is provided for flat response within 3 db from d.c. to 5 kc for use with oscilloscopes or for similar applications.
Calibration	1.0 volt signal derived from internal mercury cells.
Output impedance	Approximately 50 ohms.
Output voltage	30 volts. Because of bridge type output circuit, output terminals are operated at 30 volts above chassis.
Output current	20 ma into 1500 ohms.
Input power required	105 to 125 volts (or 95 to 115 volts), 50 to 2000 cps, 95 watts (nominal). See ROUTINE ADJUSTMENT and MAINTENANCE.
Fuse	2 amp, 250 volts, type 3AG.
Tubes	Each pen drive amplifier: 1 - 5751, 2 - 12AT7WA, and 2 - 5687. Power supply: 1 - 0A2, 1 - 6X4, 1 - 6080, 1 - 5751, and 2 - 3TF4.
Dimensions	Standard panel: 19″ wide x 5¼″ high x ¼″ thick. Depth: 10¾″ (with connectors 12½″).
Net weight	22 pounds.
Shipping weight	28 pounds.

INSTALLATION

Two types of mountings are available, rack or portable case. Installation of the Dual Channel Amplifier in a standard 19″ rack (customer supplied) is simply a matter of placing the instrument in the rack and fastening it in position with four screws through the front panel. This is a permanent installation and designed for use with other rack mounted instruments.

For maximum portability the Brush Portable Case Model BL-380, (20⅛″ wide, 6⅜″ high and 10⅜″ deep, with a dark grey metallic finish) is recommended. When the Dual Channel Amplifier and the Portable Case are purchased together the amplifier is installed in the case at the factory. If purchased separately, installation instructions are furnished with the Portable Case.

WARNING

Because the chassis is common to one side of each amplifier circuit, it is necessary to check the circuitry of the two signals to be recorded to ascertain whether the common amplifier circuit will adversely affect their operation. Normal operation of the amplifier requires grounding of the chassis. If it is not possible to ground one side of each circuit whose signal is to be recorded, the amplifier may be operated off ground when not mounted in a rack. Precautions must be taken for off-ground operation to protect the operator from electrical shock as the amplifier case will be at the potential of the common side of the circuits.

NOTE:

THE OUTPUT TERMINALS OF THIS AMPLIFIER ARE 30 VOLTS ABOVE CHASSIS. THEREFORE, SOME OF THE EARLIER BRUSH OSCILLOGRAPHS, Models BL-201, BL-202, BL-221, AND BL-222, MAY REQUIRE THE REMOVAL OF AN EXISTING PENMOTOR LEAD TO THE CHASSIS. ALL BRUSH OSCILLOGRAPHS, Models BL-206 AND BL-208, MUST BE CONVERTED FOR USE WITH THIS AMPLIFIER. SEE BELOW.

All other Brush Oscillographs need no conversion. Present owners of the "BL-200 series" of oscillographs may determine if the penmotor coil of their particular oscillograph is connected to the chassis by disconnecting the input cable from the oscillograph, turning the ON-OFF switch to "ON", and measuring the resistance from each of the two large pins of the four prong input connector to the oscillograph chassis. If the resistance is infinite, the oscillograph will operate satisfactorily with the Dual Channel D.C. Amplifier. If the resistance between either of the two large pins and the chassis is found to be zero (0) or about 1500 ohms, any connection from the penmotor leads to the chassis (usually found at the input socket of the oscillograph) must be removed.

All Brush Oscillographs, Models BL-206 and BL-208, must be converted for use with the Dual Channel D.C. Amplifier. The Brush Customer Service Department will be very glad to supply the information to make this conversion.

When operating the Amplifier Model BL-530 with balanced input, the signals to be recorded must be checked to determine that the inphase component is no greater than ± 10 volts.

CONTROLS and CONNECTORS

The controls and connectors on the front panel are as follows:

POWER OFF-ON..... "ON-OFF" switch for both channels.

The following controls and connectors are in duplicate (one for each channel). They are marked CHANNEL 1 on the left side (facing the panel) and CHANNEL 2 on the right side.

CALIBRATE-20 LINES.... Continuously variable gain control for calibrating amplifier-oscillograph combination, using an internal mercury cell as a reference voltage.

VOLTS/LINE..... Step control to attenuate input signal to amplifier.

BALANCED-SINGLE..... Selector switch either for balanced or single ended input.

PEN ZERO..... Adjusts pen position on chart to desired setting, except when balanced input is used.

GND (Ground)..... GR type terminal permits grounding of the amplifier chassis or connecting several instruments to a common ground.

INPUT 1 and 2..... GR type terminals for either single ended or balanced input signal. When a single ended input is used, connect the side of circuit to be grounded to terminal 1 and the other side of circuit to terminal 2. When a balanced input is required, connect one side of circuit to terminal 1 and the other side of circuit to terminal 2. The neutral or ground connection of the balanced input is connected to the GND (ground) terminals. The d.c. voltage level of the balanced input circuit should not exceed ± 10 volts.

The controls and connectors on the rear panel are as follows:

POWER Input..... Connects power source to amplifier (2 pin recessed male connector).

The following controls and connectors are in duplicate (one for each channel). Channel 2 is on the left side (facing the rear panel), while Channel 1 is on the right side. This is in contrast to the front panel control positions, but places the controls on the rear panel directly behind the respective controls of each channel on the front panel.

NARROW COMP..... (narrow compensator) Frequency compensator for matching penmotor. (See ROUTINE ADJUSTMENT and MAINTENANCE.)

BROAD COMP..... (broad compensator) Same as above.

TUBE ADJ..... (tube adjustment) To be used only in case of tube replacement. (See ROUTINE ADJUSTMENT and MAINTENANCE.)

INPUT 1 and 2..... This connector is in parallel with the GND and INPUT 1 and 2 terminals on the front panel. Pin "A" is in parallel with GND (ground); pin "B" is in parallel with INPUT 1; pin "C" is in parallel with INPUT 2. (3 pin male AN connector.)

OUTPUT 1 and 2..... Connects amplifier output to oscillograph or other equipment (6 pin female AN connector).

OPERATING PROCEDURE

Since each side of this Dual Channel Amplifier is a separate and complete amplifier except for a common chassis circuit, these operating procedures will consider only one channel unless specified otherwise. The information is applicable to either or both sections of the amplifier, i.e., CHANNEL 1 or CHANNEL 2 may be operated separately or both simultaneously without interference of one with the other. To operate proceed as follows:

1. Determine that the main power switch of the oscillograph is in the "OFF" position and connect the amplifier to the oscillograph.
2. Connect power cable to POWER input (on the rear panel of the amplifier) and to a 115 volt a.c. power source.
3. Turn *both* VOLTS/LINE Switches to "OFF".
4. Turn POWER Switch to "ON". Allow 10 to 15 minutes for the amplifier to warm up.
5. Turn BALANCED-SINGLE Switch to desired position for either a balanced or a single ended input signal.
6. Turn PEN ZERO *fully counterclockwise* and then *clockwise* five full turns. (The full range of this control is ten turns—thus five full turns from either right or left stop constitutes approximately the middle position.)

7. Connect the oscillograph to an appropriate power source and turn the oscillograph to "ON" at slow chart paper speed. (This is to conserve paper during adjustment period.)

8. If BALANCED-SINGLE switch is on "BALANCED" position pen should center on the center line of the chart paper. If pen is slightly off-center, adjust to center position by means of the appropriate (channel 1 or 2) TUBE ADJ control on the rear of the chassis. If BALANCED-SINGLE switch is on "SINGLE" position, pen should be centered on the center of the chart paper by means of the appropriate (channel 1 or 2) PEN ZERO control on the front panel.

9. Depress CALIBRATE Switch and adjust 20 LINES-CALIBRATE control for 20 lines of pen deflection. Release CALIBRATE switch.

10. Check 20 line deflection by again depressing CALIBRATE switch. If necessary, re-adjust as in step 9, above.

11. Connect the signal input to the amplifier by means of either the front (GR) terminals or the back (AN) connector.

    When connecting a single ended input at the front panel, the "hot" side (in reference to ground) must be connected to INPUT 2 and the side of circuit to be grounded to INPUT 1. If the rear panel input connector is used, the "hot" side of the signal must be connected to pin "C" and the ground to pin "B". When a balanced input signal is connected at the front panel, one side of the circuit is connected to INPUT 1 and the other side to INPUT 2. When a balanced input signal is connected to the rear panel input connector, one side of the circuit is connected to pin "B," and the other side to pin "C." The balanced input circuit may be grounded to the GND (ground) terminal at the front panel, or to pin "A" of the rear panel input connector.

12. Adjust pen to desired position on chart paper with PEN ZERO control if the BALANCED-SINGLE switch is on "SINGLE" position. If the control is on "BALANCED" position no adjustment should be necessary. Refer to step No. 8 above.

13. Turn VOLTS/LINE Switch to 10, 5, etc., in successive steps to reach desired sensitivity.

The signal voltage is equal to the number of lines of deflection from the pen zero, multiplied by the VOLTS/LINE setting.

OFF CENTER ZERO OPERATION
(When using single ended input only)

Under certain conditions, more complete information regarding the dynamic component of a complex signal is required. It is possible, by adjusting the zero position of the signal off the chart paper, to cancel the static component and magnify the amplitude of the recording of the dynamic component. After displaying the signal on an appropriate VOLTS/LINE setting, turn the VOLTS/LINE switch to the next lower setting. Follow this by turning the PEN ZERO control until the pen records equal amplitude of the dynamic signal component on either side of the center line of chart paper. *Note: This step is particularly important.* The above procedure may be repeated until the signal amplitude is as great as possible without exceeding 40 lines (peak to peak) or until the d.c. (static signal component) center shift is 200 lines off chart center, which is the maximum available shift on any VOLTS/LINE switch position. The peak to peak voltage of the signal under observation is equal to the number of chart lines (peak to peak) multiplied by the setting of the VOLTS/LINE switch.

ROUTINE ADJUSTMENT and MAINTENANCE

This amplifier has been accurately balanced and adjusted before shipment from the factory and should give long, trouble-free service. This amplifier is normally wired to operate with from 105 to 125 volts input. If however, the prevailing power supply is from 95 to 115 volts, a slight modification of the wiring of the power transformer (T-1) will accommodate this condition. See Tube Layout (Fig. 2) and the schematic wiring diagram. To make this modification disconnect the input power lead and capacitor lead from terminal "3" of the power transformer. Re-connect these same two leads to terminal "2" of the same transformer. The lead which connects terminal "3" to the separate filament transformer (T-2) should be re-soldered to terminal "3" of the power transformer (T-1). This modification will be made at the factory, if requested at time of ordering. For any servicing except the above modification and tube replacement, the instrument should be sent back to the factory where facilities are available to restore it to its original condition. See inside the title page for shipping instructions.

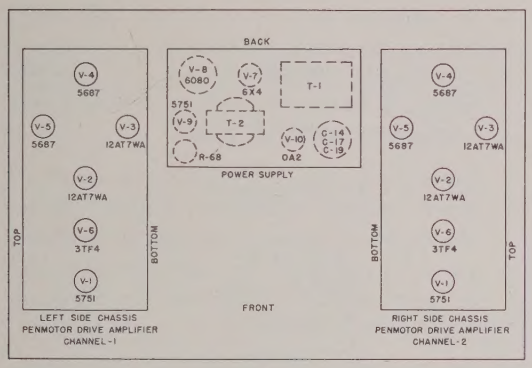

Fig. 2 Tube Layout

TUBE REPLACEMENT

To replace any faulty tube, begin by disconnecting all cables and expose the chassis. If the amplifier is portable case mounted, remove the top and bottom screws as well as the four screws on the front panel and withdraw the amplifier. If the amplifier is rack mounted, remove from the rack and take off the top portion of the wrap-around cover. In either case, all tubes will be exposed.

Either Side Chassis (Channel 1 or 2)

If any of the 5687's or the 12AT7WA's are replaced, proceed as follows:

1. Remove the 5751 (V-1) tube from the particular amplifier section in which the tube was replaced (see Fig. 2). IMPORTANT: This tube remains out during adjustment, regardless of which tube of the pen drive amplifier was replaced.
2. Connect the amplifier to an appropriate power source, turn the POWER OFF-ON switch to "ON", and allow the amplifier to warm up for 10 to 15 minutes.
3. Connect the oscillograph to an appropriate power source.
4. Turn "ON" the oscillograph and center the pen by means of the pen centering lever.
5. Connect amplifier to oscillograph and with the oscillograph connected and operating, adjust pen to zero (center line) of the chart paper, by means of the adjustment control on the back panel marked "TUBE ADJ" (tube adjustment). This operation balances the amplifier.
6. Replace the 5751 tube previously removed. Zero pen by means of the PEN ZERO control.
7. If it is necessary to replace either the 5751 or the 3TF4 tubes, no adjustment is necessary.

Power Supply Chassis

Following the replacement of any tube in this section (Fig. 2) the + B voltage must be checked and adjusted. The voltage between the case of the condenser C-14, and pin 5 of the 0A2 tube (V-10), must be adjusted to 213 volts (± 5 volts) by means of the control (R-68).

Following any tube replacement, restore the top portion of the wrap-around cover (if any) and replace the instrument in either the rack or portable case.

FREQUENCY COMPENSATION

To obtain optimum frequency response of an amplifier-oscillograph combination, the frequency response of the amplifier must be adjusted to match the penmotor of the oscillograph. (When an amplifier and an oscillograph are purchased together, this adjustment is made at the factory.)

To match either channel 1 or channel 2 of the amplifier to an oscillograph, proceed as follows:

1. Warm up amplifier (10 to 15 minutes).
2. Adjust pen pressure of oscillograph with a gram gage. (See Operating Instructions for the Oscillograph.)
3. Put BALANCED-SINGLE switch in the "SINGLE" position.
4. Connect an oscillator covering the range from 10 to 100 cps to INPUT 1 and INPUT 2 on the front panel. If the corresponding input (AN) connector on the rear panel is used, pins "B" and "C" correspond to the GR terminals marked "INPUT 1 and 2" on the front panel. Fig. 1.
5. Turn the BROAD COMP (broad compensator) switch *fully counterclockwise.*
6. At 10 cps adjust oscillator output level for 10 lines total pen deflection (peak to peak).

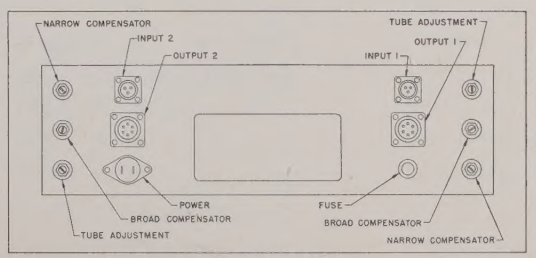

Fig. 3. Rear Panel of Amplifier.

Note: The pen deflection is a product of the oscillator output voltage, the VOLTS/LINE setting and the setting of the CALIBRATE-20 LINES control. Observe the oscillator output voltage as it is the reference voltage and must remain constant during the frequency compensation.

7. At 100 cps (with oscillator output voltage the same as in step 6, above) adjust the NARROW COMP (narrow compensator) for maximum pen deflection. If maximum pen deflection thus obtained is less than 10 lines, advance the BROAD COMP (broad compensator) *clockwise* by steps until the maximum pen deflection obtainable by adjustment of the NARROW COMP (narrow compensator) is at least 10 lines. (If extreme or erratic pen deflections are observed, the condition is due to internal oscillations within the amplifier. This is corrected by turning slightly the NARROW COMP in a *counterclockwise* direction until the condition ceases.)
8. If maximum pen deflection thus obtained is over 10 lines, adjust NARROW COMP (narrow compensator) *counterclockwise* until a pen deflection of 10 lines is obtained. Test for flatness of response from 100 to 10 cps.
9. Re-set input voltage at 100 cps as in step 7, above. Adjust NARROW COMP (narrow compensator) *clockwise* through the maximum pen deflections until a pen deflection of 10 lines is again obtained. Again test for flatness of response from 100 to 10 cps.
10. The best frequency response of the amplifier-oscillograph combination will be either that obtained in step 8 or step 9. This selection may be determined by comparing the two graphs.

NOTE: In cases where extended frequency response is desired (when the amplifier is being used with an oscilloscope or for similar applications), turn the BROAD COMP (broad compensator) control fully clockwise.

PARTS LIST

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
B-1	Cell, Mercury	1.35V, ± 1%	2-119701-1
C-1	Capacitor, Paper	2 mfd, ± 10%, 200V	10-120554-205
C-2	Capacitor, Mica	470 mmfd, ± 5%, 500V	5-117264-471
C-3	Capacitor, Mica	.001 mfd, ± 5%, 500V	5-117264-102
C-4	Capacitor, Mica	.001 mfd, ± 5%, 500V	5-117264-102
C-5	Capacitor, Mica	.001 mfd, ± 5%, 500V	5-117264-102
C-6	Capacitor, Mica	.001 mfd, ± 5%, 500V	5-117264-102
C-7	Capacitor, Mica	.001 mfd, ± 5%, 500V	5-117264-102
C-8	Capacitor, Mica	470 mmfd, ± 5%, 500V	5-117264-471
C-9	Capacitor, Mica	680 mmfd, ± 5%, 500V	5-117264-681
C-10	Capacitor, Mica	.0015 mfd, ± 5%, 500V	5-117265-152
C-11	Capacitor, Mica	.0022 mfd, ± 5%, 500V	5-117265-222
C-12	Capacitor, Paper	.01 mfd, ± 10%, 600V	10-217260-103
C-13	Capacitor, Paper	.01 mfd, ± 10%, 600V	10-217260-103
C-14	Capacitor, Electrolytic (⅓ Triple Section)	20 mfd, 450V	117718-206
C-15	Capacitor, Paper	.01 mfd, ± 10%, 400V	10-217413-103
C-16	Capacitor, Mica	.0022 mfd, ± 10%, 500V	10-117265-222
C-17	Capacitor, Electrolytic	20 mfd, 450V	(See C-14)
C-18	Capacitor, Paper	.25 mfd, ± 10%, 400V	10-120554-254
C-19	Capacitor, Electrolytic	20 mfd, 450V	(See C-14)

PARTS LIST (Cont'd)

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
E-1	Lamp, Incandescent	Type 51	105796-1
F-1	Fuse, 2 Amp., 250V	Type 3AG	102625
J-1	Binding Post (3)	GR Type	119741-3
J-2	Connector, Female	Strip Type	2-122555-2
J-3	Connector, Female	Strip Type	2-122555-5
J-4	Receptacle, Female	AN Type	119990
P-1	Receptacle, Male	AN Type	121274
P-2	Receptacle, Male		6526
R-1	Resistor, Precision	5.0M, ± 1%, ½W	1-117802-5004
R-2	Resistor, Precision	5.0M, ± 1%, ½W	1-117802-5004
R-3	Resistor, Precision	75K, ± 1%, 1W	1-117803-7502
R-4	Resistor, Variable, 10 Turn	50K	5-117686-503
R-5	Resistor, Precision	9.1K, ± 1%, ½W	1-117802-9101
R-6	Resistor, Precision	9.1K, ± 1%, ½W	1-117802-9101
R-7	Resistor, Precision	50K, ± 1%, 1W	1-117803-5002
R-8	Resistor, Precision	500K, ± 1%, ½W	1-117802-5003
R-9	Resistor, Precision	1.0M, ± 1%, ½W	1-117802-1004
R-10	Resistor, Precision	750K, ± 1%, 1W	1-117803-7503
R-11	Resistor, Precision	330K, ± 1%, ½W	1-117802-3303
R-12	Resistor, Precision	900K, ± 1%, 1W	1-117803-9003
R-13	Resistor, Precision	110K, ± 1%, ½W	1-117802-1103
R-14	Resistor, Precision	950K, ± 1%, 1W	1-117803-9503
R-15	Resistor, Precision	26K, ± 1%, ½W	1-117802-2602
R-16	Resistor, Precision	16.5K, ± 1%, ½W	1-117802-1652
R-17	Resistor, Precision	5.05K, ± 1%, ½W	1-117802-5051
R-18	Resistor, Precision	5.05K, ± 1%, ½W	1-117802-5051
R-19	Resistor, Precision	350K, ± 1%, ½W	1-117802-3503
R-20	Resistor Assembly, Variable	1M, ± 0.5%	223262-501
R-21	Resistor, Precision	250K, ± 1%, ½W	1-117802-2503
R-22	Resistor, Precision	2.5M, ± 1%, ½W	1-117802-2504
R-23	Resistor, Precision	5M, ± 1%, ½W	1-117802-5004
R-24	Resistor, Composition	1.2K, ± 5%, ½W	5-115557-122
R-25	Resistor, Precision	250K, ± 1%, ½W	1-117802-2503
R-26	Resistor, Composition	1.2K, ± 5%, ½W	5-115557-122
R-27	Resistor, Precision	5M, ± 1%, ½W	1-117802-5004
R-28	Resistor, Precision	2.5M, ± 1%, ½W	1-117802-2504
R-29	Resistor, Precision	250K, ± 1%, ½W	1-117802-2503
R-30	Resistor, Precision	6.8M, ± 1%, 1W	1-117803-6804
R-31	Resistor, Precision	2.2M, ± 1%, ½W	1-117802-2204
R-32	Resistor, Precision	2.2M, ± 1%, ½W	1-117802-2204
R-33	Resistor, Precision	6.8M, ± 1%, 1W	1-117803-6804

PARTS LIST (Cont'd)

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
R-34	Resistor, Composition	100K, ± 5%, ½W	5-115557-104
R-35	Resistor, Composition	3.6K, ± 5%, ½W	5-115557-362
R-36	Resistor, Variable	3K, ± 20%, ½W	20-125156-302
R-37	Resistor, Composition	3.6K, ± 5%, ½W	5-115557-362
R-38	Resistor, Composition	100K, ± 5%, ½W	5-115557-104
R-39	Resistor, Precision	1.1M, ± 1%, ½W	1-117802-1104
R-40	Resistor, Precision	510K, ± 1%, ½W	1-117802-5103
R-41	Resistor, Composition	11K, ± 5%, ½W	5-115557-113
R-42	Resistor, Precision	510K, ± 1%, ½W	1-117802-5103
R-43	Resistor, Precision	1.1M, ± 1%, ½W	1-117802-1104
R-44	Resistor, Composition	100K, ± 5%, ½W	5-115557-104
R-45	Resistor, Precision	1.72M, ± 1%, ½W	1-117802-1724
R-46	Resistor, Precision	470K, ± 1%, ½W	1-117802-4703
R-47	Resistor, Composition	18K, ± 5%, ½W	5-115557-183
R-48	Resistor, Precision	470K, ± 1%, ½W	1-117802-4703
R-49	Resistor, Precision	1.72M, ± 1%, ½W	1-117802-1724
R-50	Resistor, Composition	100K, ± 5%, ½W	5-115557-104
R-51	Resistor, Composition	1.1K, ± 5%, 2W	5-115559-112
R-52	Resistor, Composition	680 Ohms, ± 5%, ½W	5-115557-681
R-53	Resistor, Composition	2.2M, ± 5%, ½W	5-115557-225
R-54	Resistor, Composition	1.0M, ± 5%, ½W	5-115557-105
R-55	Resistor, Composition	1.0M, ± 5%, ½W	5-115557-105
R-56	Resistor, Variable	1.0M	19-211473-105
R-57	Resistor, Composition	1.0M, ± 5%, ½W	5-115557-105
R-58	Resistor, Composition	1.0M, ± 5%, ½W	5-115557-105
R-59	Resistor, Composition	2.2M, ± 5%, ½W	5-115557-225
R-60	Resistor, Composition	68 Ohms, ± 5%, 1W	5-115558-680
R-61	Resistor, Composition	68 Ohms, ± 5%, 1W	5-115558-680
R-62	Resistor, Composition	100 Ohms, ± 5%, ½W	5-115557-101
R-63	Resistor, Precision	1.0M, ± 1%, ½W	1-117802-1004
R-64	Resistor, Precision	5.0M, ± 1%, ½W	1-117802-5004
R-65	Resistor, Precision	5.0M, ± 1%, ½W	1-117802-5004
R-66	Resistor, Precision	1.0M, ± 1%, ½W	1-117802-1004
R-67	Resistor, Precision	390K, ± 1%, ½W	1-117802-3903
R-68	Resistor, Variable	100K	19-211473-104
R-69	Resistor, Precision	150K, ± 1%, ½W	1-117802-1503
R-70	Resistor, Composition	220K, ± 5%, ½W	5-115557-224
R-71	Resistor, Composition	10K, ± 5%, 2W	5-115559-103
R-72	Resistor, Composition	330K, ± 5%, ½W	5-115557-334
R-73	Resistor, Composition	220K, ± 5%, ½W	5-115557-224
S-1	Switch, Rotary		119867
S-2	Switch, Rotary		119652
S-3	Switch, Toggle, Momentary		124334

PARTS LIST (Cont'd)

SYMBOL	DESCRIPTION	VALUE	BRUSH PART NO.
S-4	Switch, Rotary		118828
S-5	Switch, Rotary		119052
T-1	Transformer, Power		121553
T-2	Transformer, Filament		123991
V-1	Tube, Electron 5751		119028
V-2	Tube, Electron 12AT7WA		122813
V-3	Tube, Electron 12AT7WA		122813
V-4	Tube, Electron 5687		122828
V-5	Tube, Electron 5687		122828
V-6	Tube, Ballast 3TF4		119373
V-7	Tube, Electron 6X4		117614
V-8	Tube, Electron 6080		115267
V-9	Tube, Electron 5751		119028
V-10	Tube, Electron 0A2		107098
	Cable, Signal		223385-501
	Cable, Power		117630

TUBE SOCKET PIN VOLTAGES

1. Voltages should be measured under the following conditions:
   a. VOLTS/LINE attenuator set in the "OFF" position.
   b. CALIBRATE—20 LINES control fully counterclockwise.
   c. A 1500 ohm resistor connected across the output terminals (pins "B" and "C" of the output connector).
   d. Voltage across the output resistor adjusted to zero (0 volts) by means of the PEN ZERO control.
2. D.C. measurements should be made with a DC voltmeter with a minimum of ten (10) megohms input impedance.
3. A.C. voltages should be measured with an accurate RMS AC voltmeter (20,000 ohms per volt or higher).
4. The +B voltage should be adjusted to 213 volts as described in the Operating Instructions under "ROUTINE ADJUSTMENT AND MAINTENANCE—Power Supply Chassis".
5. All measurements should be made from the tube pin to —B (⏚) point, except where otherwise noted.
6. Variations in observed voltage readings from tabulated values do not necessarily indicate improper operations unless deviations exceed 10%.

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TUBE No.	TYPE	PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V-1	5751	165	86	88	Note 1		165	86	88	—
V-2	12AT7WA	110	Note 3	29	Note 2		110	Note 3	29	—
V-3	12AT7WA	110	Note 3	36	Note 2		110	Note 3	36	—
V-4	5687	213	110	113	Note 4		113	110	—	213
V-5	5687	113	23	26	Note 4		26	23	—	113
V-7	6X4	—	—	—	—	—	—	—	—	—
V-8	6080	—	—	—	—	—	—	—	—	—
V-9	5751	Note 3		65	Note 2		Note 3		65	—
V-10	0A2	—	65	—	—	213	—	—	—	—

NOTES:

1. 4.4 to 5.8 volts A.C. measured from pins 4 and 5 to pin 9.
2. 6.3 volts A.C. measured from pins 4 and 5 to pin 9.
3. Do not measure.
4. 6.3 volts A.C. measured from pins 4 and 5 to pin 8.

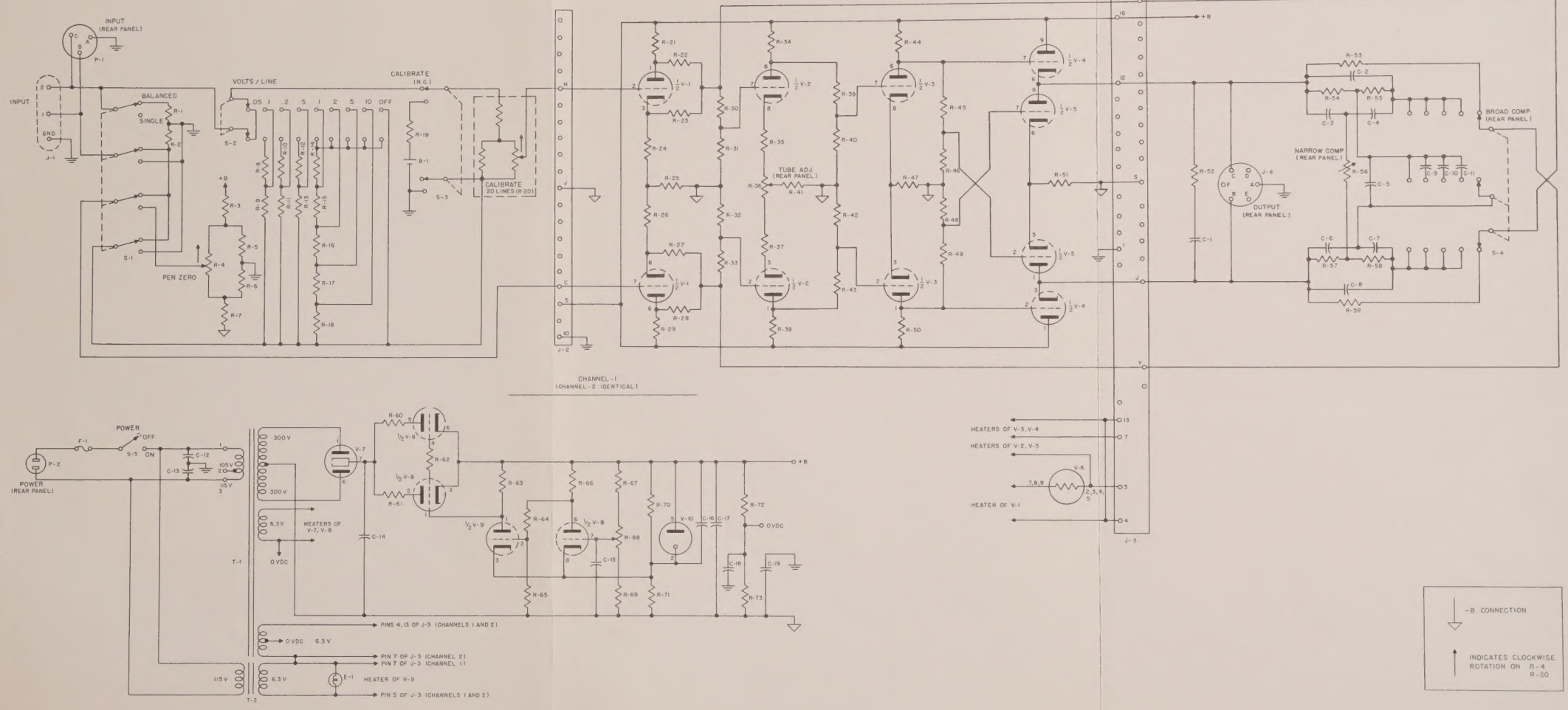
BRUSH ELECTRONICS COMPANY

3405 PERKINS AVE. • CLEVELAND 14, OHIO • U.S.A.

Division of Clevite Corporation

Instrument Department

INDUSTRIAL AND RESEARCH INSTRUMENTS • PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS


INPUT (REAR PANEL)
INPUT
BALANCED
SINGLE
VOLTS / LINE
.05 .1 .2 .5 1 2 5 10 OFF
CALIBRATE (N.C.)
CALIBRATE 20 LINES (R-20)
PEN ZERO
TUBE ADJ. (REAR PANEL)
BROAD COMP. (REAR PANEL)
NARROW COMP. (REAR PANEL)
OUTPUT (REAR PANEL)
CHANNEL - 1 (CHANNEL - 2 IDENTICAL)
POWER
POWER (REAR PANEL)
HEATERS OF V-7, V-8
HEATERS OF V-3, V-4
HEATERS OF V-2, V-5
HEATER OF V-1
HEATER OF V-9
PINS 4, 13 OF J-3 (CHANNELS 1 AND 2)
PIN 7 OF J-3 (CHANNEL 2)
PIN 7 OF J-3 (CHANNEL 1)
PIN 5 OF J-3 (CHANNELS 1 AND 2)
-B CONNECTION
INDICATES CLOCKWISE ROTATION ON R-4 R-20

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